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Application Number 10/541484
Response to the Office Action dated 04/08/2008

Amendments to the Specification:

The listing of the specification will replace all prior versions of the corresponding paragraphs of the specification in the application.

Please amend the title of the specification as follows:

METHOD ~~AND APPARATUS~~ FOR ~~PRODUCING~~ MANUFACTURING ELECTRICALLY CONDUCTIVE ~~POLYMER~~ MACROMOLECULES AND SOLID STATE ELECTROLYTIC CAPACITOR USING ELECTRICALLY CONDUCTIVE MACROMOLECULES

Please amend the paragraph appearing at lines 29-35 of page 3 of the specification as follows:

The method for manufacturing electrically conductive macromolecules of the present invention is a method for manufacturing electrically conductive macromolecules by reacting at least a monomer and an oxidizing agent to obtain electrically conductive macromolecules by a chemical polymerization method, the method comprising; reacting the monomer and the oxidizing agent in a polymerizing vessel that contains at least a ~~supersaturated~~ steam (water vapor) atmosphere.

Please amend the paragraph appear from line 36 of page 3 of the specification to line 8 of page 4 of the specification as follows:

The apparatus for manufacturing the electrically conductive molecules of the present invention is an apparatus for manufacturing electrically conductive macromolecules, for polymerizing at least a monomer and an oxidizing agent in a polymerizing vessel, wherein the polymerizing vessel that contains ~~a supersaturated~~ steam atmosphere includes a device for providing dry air and steam that is generated by a heat exchanger to the polymerizing vessel, at least in the polymerizing vessel, and

wherein the reaction of the monomer and the oxidizing agent at least occurs within the polymerizing vessel in the~~-supersaturated~~ steam atmosphere.

Please amend the paragraph appearing at lines 33-35 of page 4 of the specification as follows:

FIG. 6A is a plan view for explaining how the polymerized film that is polymerized in a~~-supersaturated~~ steam atmosphere of Working Example 2 is attached, and FIG. 6B is a cross-sectional view of the same.

Please amend the paragraph appearing at lines 18-27 of page 5 of the specification as follows:

The present invention includes reacting at least a monomer and an oxidizing agent to obtain electrically conductive macromolecules by a chemical polymerization method, wherein the monomer and the oxidizing agent are reacted at least in a polymerizing vessel that contains a~~-supersaturated~~ steam atmosphere. Furthermore, it is desirable that the steam concentration of the~~-supersaturated~~ steam atmosphere is at least 5 vol%. This is in order both to reduce the vaporization speed of the solvent, and to increase the temperature of the polymerized body. If the steam concentration is less than 5 vol%, then it tends to be difficult to achieve both.

Please amend the paragraph appearing at lines 28-32 of page 5 of the specification as follows:

It is desirable that the temperature of the~~-supersaturated~~ steam atmosphere is at least 85°C. The polymerization reaction rate increases with increased temperature, and thus it is possible to increase the yield of the polymer film, and decrease the time for the polymerization reaction.

Please amend the paragraph appearing from line 33 of page 5 to line 2 of page 6 as follows:

Before reacting the monomer and the oxidizing agent in a polymerizing tank having ~~a supersaturated~~ steam atmosphere, it is possible that preliminary polymerization is performed in advance at a temperature of less than 85°C. By preliminary polymerization, the polymerization solution seeps into fine aperture portions by capillary action, and reacts, and there is an advantage in that it is possible to fill the polymer film into the internal portions of the fine apertures.

Please amend the paragraph appearing from lines 3-6 of page 6 of the specification as follows:

Furthermore, it is desirable that the concentration of oxygen in the~~ supersaturated~~ steam atmosphere is less than 21 vol%. In this way, it is possible to prevent oxidation degeneration of the previously formed polymer film when repeating the polymerization.

Please amend the paragraph appearing at lines 23-33 of page 6 of the specification as follows:

Furthermore, an apparatus, including the polymerizing vessel that contains the ~~supersaturated~~ steam atmosphere has at least a device for providing dry air and steam that is generated by a heat exchanger to the polymerizing vessel. Furthermore, it is desirable that the temperature of the steam generated by the heat exchanger is higher than the temperature of the dry air. This is so as to reduce variations in the steam concentration in the polymerizing vessel. In this case, if the temperature of the steam that is generated by the heat exchanger is higher than the temperature of the dry air, then the steam, which has the higher thermal capacity, contacts the polymerized body, and thus the temperature of the polymerized body can be increased rapidly.

Please amend the paragraph appearing from line 34 of page 6 of the specification to line 13 of page 7 of the specification as follows:

Furthermore, the present invention provides electronic components, in particular solid state electrolytic capacitors employing electrically conductive macromolecules in which an electrically conductive macromolecular film that is flat is obtained by any method described above. Furthermore, the present invention provides electronic components, in particular solid state electrolytic capacitors employing an electrically conductive macromolecular film, wherein the density of the surface and the rear of the electrically conductive macromolecular film is substantially the same. Moreover, the present invention provides a method for manufacturing solid state electrolytic capacitors that includes a step of reacting a monomer and an oxidizing agent at 60°C or less (with no restriction on steam, this may be in a dry atmosphere) and a step of polymerizing in a polymerizing vessel in ~~a supersaturated~~ steam atmosphere of at least 85°C in order that dosing of the electrically conductive macromolecules into the anodic conductor of the solid state electrolytic capacitor, which is a porous body containing numerous fine pores, is facilitated.

Please amend the paragraph appearing at lines 14-36 of page 7 of the specification as follows:

With the present invention, it is possible to provide a low resistance electrically conductive macromolecular film whose polymerization speed on the base material side and on the opposite, vapor phase side is substantially the same, whose density is substantially the same, and whose adhesion to the base material, in particular glass and ceramics, is favorable, and a method for manufacturing the same, by reacting at least a monomer and an oxidizing agent to obtain electrically conductive macromolecules by a chemical polymerization method, the method at least comprising reacting the monomer and the oxidizing agent in a polymerizing vessel that contains ~~a supersaturated~~ steam atmosphere, and to provide electrically conductive macromolecules wherein delamination from the base material is small because warp of the electrically conductive macromolecular film is small, and the film is flat. Furthermore, it is possible to reduce the oxygen concentration (oxygen partial pressure), and to reduce oxygen degradation of

the electrically conductive macromolecules by ~~supersaturation with~~ using steam to provide low resistance electrically conductive macromolecules. Thus, it is possible to provide solid state electrolytic capacitors that suitably combine both low ESR and large capacity, and a method for manufacturing the same, and also to provide electronic components in which the electrically conductive macromolecules are used, and methods for manufacturing those components.

Please amend the paragraph appearing at lines 23-37 of page 10 of the specification as follows:

~~Supersaturated~~ [[s]]Steam in the polymerizing vessel was obtained by introducing dry air and steam, which is water that has been vaporized by a heat exchanger, into the polymerizing vessel as schematically shown in FIG. 9. In this case, when the temperature of the steam that has been generated by the heat exchanger is higher than the temperature of the dry air, the steam, which has the higher thermal capacity, contacts the polymerized body, and thus it is possible to increase rapidly the temperature of the body that is polymerized. Moreover, the dry air and the steam may be mixed in advance and then introduced into the polymerizing vessel, as shown in FIG. 10. This is in order to reduce variability in the concentration of the steam in the polymerizing vessel. In this case, when the temperature of the steam that is generated by the heat exchanger is higher than that of the dry air, the steam, which has the higher thermal capacity, contacts the polymerized body, and thus it is possible to increase rapidly the temperature of the polymerized body.

Please amend the paragraph appearing from lines 1-11 of page 11 of the specification as follows:

As is made clear in FIG. 1 and FIG. 2, by performing polymerization in a ~~supersaturated~~ steam atmosphere, because the speed of polymerization on the base material side of the glass substrate, which is the base material, is substantially the same as the speed of polymerization on the vapor phase side on the opposite surface, and the

density is also substantially the same, and because adhesion of the molecules to the glass is favorable and the electrically conductive macromolecular film has little warping and is flat, it is possible to provide electrically conductive macromolecules that have little delamination from the base material, and it is possible to apply the electrically conductive macromolecules to use in electronic components.

Please amend the paragraph appearing from line 23 of page 11 of the specification to line 12 of page 12 of the specification as follows:

The anodic conductor was washed and dried, after which the solid state electrolyte was formed. Here, poly-3,4-ethylenedioxythiophene was formed as the electrically conductive macromolecules. First, chemical oxidation polymerization was performed in order to impart electrical conductivity to the dielectric layer. The polymerizing solution was formulated by mixing 1.8 g of 3,4-ethylenedioxythiophene, 44 g of an ethanol solution containing 40 wt% iron (III) alkylnaphthalenesulfonate and 30 g of water. The anodic conductor was immersed in the polymerizing solution and polymerized in air at 40°C for 10 min, after which chemical oxidation polymerization was performed by repeating the polymerization operation six times in a combination of five conditions of steam concentrations of 70 vol%, 40 vol%, 10 vol%, 5 vol% and 0 vol%, and four conditions of temperatures of 85°C, 105°C, 155°C and 205°C. Continuing, the dielectric layer was resynthesised in a 0.1% concentration solution of acetic acid at a resynthesizing voltage of 7.5 V, and restored. Moreover, the anodic conductor was washed in pure water at about 90°C, and dried in air at about 120°C. FIGS. 5A – 5C schematically show top and cross-sectional views of elements created in conditions of 155°C and moisture ratio of 0 vol% (comparative example) and FIGS. 6A – 6B schematically shows top and cross-sectional views of elements created in conditions of 155°C and a moisture ratio of 70 vol%. No delamination was observed in the electrically conductive macromolecular film created in the conditions of 155°C and ~~supersaturated~~ steam of 70 vol%. In this way, an anodic conductor in which a dielectric layer and an electrically conductive macromolecular film are formed by chemical

oxidation polymerization was obtained as a film forming substrate for electrolytic oxidation polymerization.

Please amend the paragraph appearing at lines 14-23 of page 13 of the specification as follows:

As shown in FIGS. 7A – 7B and FIGS. 8A – 8B, it can be seen that large capacity, low ESR and low leak current electrolytic capacitors can be obtained by polymerization in ~~a supersaturated~~ steam atmosphere. Furthermore, it was possible to reduce the oxygen concentration (oxygen partial pressure) and reduce the oxygen degradation of the electrically conductive macromolecules to obtain low resistance electrically conductive macromolecules, and to obtain electrically conductive macromolecules whose film delamination is small, so that solid state electrolytic capacitors that suitably combine both low ESR and large capacity were obtained.

Please amend the paragraph appearing at lines 19-30 of page 15 of the specification, which was preliminary amended, as follows:

As shown in Table 1, it can be seen that large capacity, low ESR and low leak current electrolytic capacitors can be obtained by polymerization in ~~a supersaturated~~ steam atmosphere. Furthermore, it is possible to reduce the oxygen concentration (oxygen partial pressure) and reduce the oxygen degradation of the electrically conductive macromolecules to obtain low resistance electrically conductive macromolecules, and to obtain electrically conductive macromolecules whose film delamination is small, so that solid state electrolytic capacitors that suitably combine both low ESR and large capacity are obtained. Results similar to those of Working Example 2 could be obtained, and it can be seen that polymerization within ~~supersaturated~~ steam can be suitably used over a wide range of applications.

Please amend the paragraph appearing at lines 16-24 of page 16 of the specification as follows:

4. A method for manufacturing a solid state electrolytic capacitor that includes an anodic conductor made from valve metal, a dielectric layer formed on the surface of the anodic conductor, and a solid state electrolyte that is formed on the surface of the dielectric layer and that includes at least an electrically conductive macromolecular layer, wherein the anodic conductor is manufactured by a step of reacting a monomer and an oxidizing agent at 60°C or less, and a step of polymerizing in a polymerizing vessel in a ~~supersaturated~~ steam atmosphere at a temperature of at least 85°C.